Description

Method for producing electric conductive structures for use in high frequency technology

The invention relates to a method for producing electric conductive structures for use in high frequency technology on a conductive structure carrier.

Current circuit board technology requires very large structures for resonators, bandpass filters, band-stop filters and also for spiral inductors. For applications with thinner insulation layers, typically of an order of magnitude of 50 μm, the current relatively high conductor track tolerances for series products often do not allow the use of microstrip conductors. In any event the possible uses of microstrip conductors are greatly restricted by the relatively high conductor track tolerances. They are for example not currently suitable for high frequency technology applications. For applications with ceramics long throughput times are needed compared to circuit boards serving as conductive structures. In addition the yield in the use of ceramics is significantly less good when compared to printed circuit boards. Ceramics is also not suitable for use as an optical carrier.

To avoid the large structures for resonators, bandpass filters, band-block filters and also for spiral inductors components have therefore, for reasons of space, previously been placed on the surface of the circuit board. These components then increase the cost of the board. Added to this were the costs of placing the components on the circuit board. A further disadvantage was that areas had to be prepared on the surface of the circuit board to accept the components.

Microstrip conductors were however already used on what are known as FR 4 printed circuit boards with sufficiently large available areas

in the HF part. However this was restricted especially to areas of the surface which had a comparatively large layer spacing of, for example,.> 100 μm to the HF structures. Tolerances in the conductor tracks could be accepted for these layer spacings.

A method for producing electric conductive structures on a conductive structure carrier is known from document EP-A-0 5564 A1, with tin or a tin-lead alloy being used as a resist. A resist layer is applied to a metal layer and structured with the aid of a laser. The areas of the metal layer thus revealed are then removed by etching.

In addition for example the resist ma-N 2403 in particular for example from the resist series ma-n 2400 made by micro resist technology GmbH Rev.:2/01 is known from product information.

The object of the present invention is to specify a method for producing electric conductive structures for use in high frequency technology on a conductive structure carrier with layer spacings of significantly less than 100 μm using microstrip conductors.

In accordance with the invention this object is achieved by a method featuring the steps specified in Claim 1.

Accordingly a combination of laser structuring methods and etching methods is used in connection with a resist with high adhesion which at least as regards the lasering in the laser structuring methods, the etching in the etching methods and the minimum thickness with which it can be applied to the conductive structure carrier, has properties which at least correspond to those of chemical tin or of an amorphous resist.

Chemical tin can be applied at a strength of around 1 μm. An amorphous resist can even only be applied at a strength of far less than 20 μm. The thinner a resist can be applied, the better it is for the current method. Previous resists had a layer thickness of far greater than 20 μm. The far thinner resists allow laser treatment to be performed far more precisely. With an optimized fabrication process structures extending down into the 20 or 10 μm range and lower are thus possible. These fine structures enable electric conductive structures that can be used with high-frequency technology to be embodied, replacing the conventional components, with their corresponding disadvantages, which would otherwise be needed. In particular the conductor structures can be embodied so as to form capacitors, coils and resistors with the desired values and occupying the smallest space for use with high-frequency technology. In this case the laser structuring method allows structuring which is relatively simple compared to photographic methods but can still be undertaken at high speed. The combination of a laser structuring method with an etching method has the further advantage that full surface areas can be removed at the same time as the removal of other areas. This saves time but is also frequently needed so that the electric conductive structures used for high frequency technology are not adversely affected by the electrical voltage fields which might be present because of the full-surface areas.

Overall this method allows structured conductor tracks with small tolerances to be implemented on the inner layers or also on the outer layers of a circuit board as microstrip conductors with almost any given functions over the entire fabricated wafer. The conductor track width can be restricted to almost any degree. Currently tolerances of < +/- 5 μm are already possible. Previously typical tolerances were in the size range of +/-25 μm.

Advantageous embodiments of the invention are the subject of the subclaims.

Accordingly an FR 4 carrier material is used as a conductive structure. This material is known and low-cost.

The advantage of chemical tin or of an amorphous resist is that, in conjunction with a combination of a laser structuring method and an etching method, conductor structures usable with high-frequency technologies can be implemented.

The invention is explained in more detail below with reference to drawings. These show:

Figure 1	a basic procedural sequence of the method in accordance with the invention,
Figure 2	a part of a larger circuit board structure fabricated using the method in accordance with Figure 1, shown in cross-section with a conductor structure usable with high-frequency technology and a structure not usable with high-frequency technology,
Figure 3	a comparison in size between a conductor structure in accordance with the invention and in accordance with a corresponding conventional technology,
Figures 4 to 7	the steps involved in producing a coil in accordance with the invention,
Figures 8 to 10	a side view of three completed applications in a circuit board which have been implemented in accordance with the invention,
Figures 11 and 12	further applications in accordance with the invention,
Figures 13 to 16	Application examples in accordance with the invention in relation to a capacitor, a coil, a

resistor and a moisture sensor.

The laser-structured Partial High Density Interconnection (PHDI) shown in Figure 1 shows a conductor structure carrier 1 (substrate, e.g. an FR 4 circuit board), of which the surface is initially pre-treated is an appropriate manner so as to enable a thin layer 2 of chemical copper to be applied. In a subsequent electrolytic coating a further copper coating 3 is then applied, with a total coating thickness of up to 3 µm in the current exemplary embodiment. Subsequently a thin resist layer 4, here consisting of chemical tin, with a layer thickness of around 1 µm, is applied.

The coating phase is followed by a structuring phase. The structuring is performed with a laser, as shown in Figure 1. In the structuring phase the chemical tin layer 4 is milled away with the laser 5 at those points at which the copper coating 3 below the chemical tin layer 4 is to be subsequently removed.

After the structuring phase, as already indicated, the revealed copper layer 3 is etched away. Finally the existing chemical tin layer is stripped away.

In Figure 2 the area at the top left shows an inventive conductor structure 6 whereas the area in the center is a conventional conductor structure 7.

The inventive conductor structure 6, which is a new HF structure, features coating spacings 8 of for example 30 µm. By contrast the conventional conductor structure 7 features coating spacings 9 of for example 180 µm.

Also shown in Figure 2 in connection with the new HF structures is an individual micro through contacting 10 and a number of microstrip conductors 11 of high quality.

Figure 3 shows a visual comparison of the size of the surface areas when a specified line structure is implemented in accordance with the invention, that is in new technology 12, and in accordance with conventional, i.e. old technology 13.

Figures 4 to 7 illustrate the step-by-step implementation of a coil realized with microstrip conductors in accordance with the invention. Figure 4 here shows a copper surface with an edge length of 1 mm. The copper surface is structured with a laser in the individual production steps. In Figure 5 a coil shaped like a snail can already be seen. In Figure 6 the disruptive edge surfaces have been removed. In Figure 7 the coil is completed.

Figures 8 to 10 again show a side view of completed applications, based here on coils in each case. The shape and size of the Figures can be chosen at random. In the exemplary embodiment shown the most compact form was selected in each case.

Figure 11 shows a possible application within the circuit board below a component.. In the form shown no component placement surface of the circuit board is needed. The coil could also be accommodated at any other points in the layout.

In detail a component 14 can be seen which is connected in a substrate L1 with a pad 15. Below the substrate L1 or the pad 15, in a substrate L2 in new technology a coiled conductor structure is

implemented, as is also shown in Figure 8 for example. Below the substrate 2 and below the coiled conductor structure a substrate L3 corresponding to the substrate L1 is arranged.

There is also an enlarged view of the section integrated into Figure 11 which shows an enlargement of the surface and the depth around pad 15. Here the enlarged section also shows an individual micro through-contacting 16, with which in the present exemplary embodiment through-contacting between substrate L1 and substrate L2 is established.

Figure 12 shows an application as capacitors below a pad. The use of suitable insulating coatings and low coating thicknesses below them, e.g. up to 25 μm, allows capacitors typically ranging up to 20 pF to be implemented in the smallest space. These capacitors have the additional advantage of barely having any inductive effect.

In detail a component 17 can be seen which is connected in a substrate L1 with a pad 18. Below the substrate L1 or below the pad 18 a conductor piece 19 is implemented in new technology in a substrate L2, below this again in a substrate L3 a further pad is arranged. In this case a first insulation layer 21 or a second insulation layer 22 are arranged between the substrate L1 and the conductor piece 19 on one side and between the conductor piece 19 and the substrate L3 on the other side. To summarize, a multilayer capacitor between the pads 18, 20 is implemented with this arrangement.

A further enlarged sectional view is also integrated into Figure 12, as in Figure 11, showing an enlarged area of the depth and the surface around the pad 18.

Figure 13 shows a application relating to an HF capacitor. Figure 14 shows an application relating to an HF coil. Figure 15 shows an application relating to an HF resistor and Figure 16 shows an application relating to a moisture sensor.

The components in this case are realized in Figures 13, 14, 15 within a component area BE-F covered by a component next to a

component pad surface BE-P which can also be seen as a component solder surface piece BE-A for an electrical connection with these said components.

In Figure 16 the component involved is shown on its own.

For the realization of the HF capacitor shown in Figure 13 with an HF structure 23 in PHDI technology a capacitor surface area 24 of around 1 mm^2 is needed for the capacitor to have a capacitance of 1 pF. In this case high-quality conductor tracks 25 for the connection of the capacitor have a width of about 20 μm for example.

For the realization of the HF coil with an HF structure 26 in PDHI technology shown in Figure 14 a coil surface for an approx. 1 mm long stripline is needed which is realized with high quality with a conductor track 27.

A micro through-contacting 28 with a diameter of 0.08 mm is implemented for a midpoint connection of the coil.

For the realization of the HF resistor shown in Figure 15 a first copper layer for a first connection surface 29 and a second copper

layer for a second connection surface are implemented, between which a prespecified foil type is interleaved.

The connection surfaces 29. 30 combined as surfaces 32 are high-quality surfaces. Resistance values of the HF resistor are determined using the interleaved foil type and the connection surfaces. The calibration is undertaken in PHDI technology.

The exemplary embodiment in accordance with Figure 15 finally shows a conductor track 33 for the first connection and a conductor track 34 for the second connection of the HF resistor.

The moisture sensor depicted in Figure 16 is shown at two points in time. In the upper part of Figure 16 the moisture sensor is shown before the laser process whereas in the lower part of Figure 16 it is shown after the laser process.

Before the laser process there only exists one high-quality surface 35 into which conductor tracks 36 with a high-quality width are incorporated with the laser process. The width in the exemplary embodiment shown is at least 25 μm.

For the moisture sensor in Figure 16 conductor tracks 37 are realized for its connection, which in the exemplary embodiment shown have a width of 0.1 mm.